

PATENT APPLICATION TRANSMITTAL LETTER

Docket Number NEM-01701

11/17/99

Patent Group
 Foley, Hoag & Eliot LLP
 One Post Office Square
 Boston, MA 02109-2170

JC525 U.S. PTO
09/442353
11/17/99

To the Assistant Commissioner for Patents:

Transmitted herewith for filing under 35 U.S.C. 111 and 37 CFR 1.53 is the patent application of

Hironori Kikkawa and Michiaki Sakamotoentitled REFLECTION TYPE LIQUID CRYSTAL DISPLAY PROVIDED WITH TRANSPARENT PIXEL ELECTRODE AND MANUFACTURE METHOD THEREOF

Enclosed are:

- (X) 36 pages of written description, claims and abstract.
- (X) 5 sheets of drawings.
- (X) an assignment of the invention to NEC Corporation and check for \$40.00.
- (X) executed declaration of the inventors.
- (X) certified copy of Japanese application no. 10-327712.
- (X) information disclosure statement and cited references.

CLAIMS AS FILED

	NUMBER FILED	NUMBER EXTRA	RATE	FEE
BASIC FEE (37 CFR 1.16(a))			\$760	\$760
TOTAL CLAIMS (37 CFR 1.16(c))	24-20 =	4	x \$18	\$72
INDEPENDENT CLAIMS (37 CFR 1.16(b))	2-3 =	0	x \$78	0
MULTIPLE DEPENDENT CLAIM PRESENT		(37 CFR 1.16(d))	\$260	
* NUMBER EXTRA MUST BE ZERO OR LARGER			TOTAL	\$832
	If applicant has small entity status under 37 CFR 1.9 and 1.27 then divide total fee by 2, and enter amount here.		SMALL ENTITY	\$

(X) A check in the amount of \$832 to cover the filing fee is enclosed.

(X) The Commissioner is hereby authorized to charge and credit Deposit Account No. **06-1448** as described below. I have enclosed a duplicate copy of this sheet.

- () Charge the amount of \$ _____ as filing fee.
- (X) Credit any overpayment.
- (X) Charge any additional filing fees required under 37 CFR 1.16 and 1.17.
- () Charge the issue fee set in 37 CFR 1.18 at the mailing of the Notice of Allowance, pursuant to 37 CFR 1.311(b).

Certificate of Express Mail

I hereby certify that this correspondence is being deposited with the United States Postal Service as Express Mail, postage prepaid, "Post Office to Addressee", in an envelope addressed to the Assistant Commissioner for Patents, Box Patent Application, Washington, D.C. 20231 on this date of November 17, 1999.

Carmen Parra
 Carmen Parra

Express Mail Label: EL354729192US

Donald W. Muirhead
 Donald W. Muirhead
 Reg. No. 33,978

Reflection Type Liquid Crystal Display Provided with
Transparent Pixel Electrode and Manufacture Method thereof

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

The present invention relates to a liquid crystal display and a manufacture method thereof, particularly to a reflection type liquid crystal display provided with a thin film transistor and a manufacture method thereof.

10 2. Description of the Prior Art

A so-called active matrix type liquid crystal display provided with switching elements such as thin film transistors is constituted of a thin film transistor substrate (hereinafter referred to as the TFT substrate) in which a plurality of thin film transistors are arranged in a matrix manner, and an opposite substrate provided with a transparent common electrode and disposed opposite to the TFT substrate via a liquid crystal layer. In a color liquid crystal display, a color filter layer is formed on either the TFT substrate or the opposite substrate.

Moreover, the color liquid crystal display is largely classified into a reflection type liquid crystal display using a pixel electrode on the side of the TFT substrate formed of an opaque reflective metal, and a transmission type liquid crystal display using a transparent pixel electrode.

When the color filter layer is formed on the side

of the TFT substrate, as compared with when the color filter layer is formed on the side of the opposite substrate, no overlap margin of the TFT and opposite substrates is necessary, the aperture ratio can be
5 increased, and brighter display can be performed, which is a preferable mode. Examples of the formation of the color filter layer on the side of the TFT substrate include the transmission type liquid crystal display as disclosed in Japanese Patent Application Laid-Open No. 72473/1995 and the reflection type liquid crystal display as disclosed in
10 Japanese Patent Application Laid-Open No. 254696/1996.

In the former transmission type liquid crystal display, in which the pixel electrode is transparent, even if the color filter layer is disposed on the side of the TFT substrate, the transparent pixel electrode can be disposed on the side of the liquid crystal. Therefore, only little influence is exerted to the electric field applied to the liquid crystal. In the latter reflection type liquid crystal display, however, since the reflective pixel electrode has to be formed below the color filter layer, the interval between the common electrode on the side of the opposite substrate and the pixel electrode is broadened by the thickness of the color filter layer, and the electric field applied to the liquid crystal is
20 weakened, which causes a problem that the liquid crystal drive efficiency is lowered.
25

Moreover, the transmission type liquid crystal

display and the reflection type liquid crystal display are different not only in the constituting conditions of the pixel electrode, but also in the position in which the pixel electrode is formed. When the liquid crystal
5 displays different in the manufacture processes for reasons such as the difference of the layer structure are manufactured on the same manufacture line, optimum conditions in forming the films or performing etching or the like also change, and the setting of a manufacture device has to be changed. Since the setting change requires much time, the production efficiency is remarkably deteriorated. Moreover, since the manufacture device of the liquid crystal display is very expensive, the addition of the manufacture device to eliminate the setting change-over results in a manufacture cost increase.

Furthermore, as a special example, as disclosed in Japanese Patent Application Laid-Open No. 29787/1996, the liquid crystal display which can be applied to both the transmission type and the reflection type has also been
20 proposed. This proposal comprises employing a color development layer including a fluorescent material to obtain a brighter color filter than the conventional color filter, forming the color development layer on a reflective layer even in the reflection type, and forming the
25 transparent pixel electrode on the color development layer.

However, even in such reflection type liquid crystal display, the reflective layer is newly disposed

using a metal different from the wiring metal of the thin film transistor in a separate process, and the manufacturing of the reflection type liquid crystal display and the transmission type liquid crystal display using the 5 same manufacture line is not considered at all.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a reflection type liquid crystal display and a manufacture method therefor, which can be manufactured on the same manufacture line as that of a transmission type liquid crystal display and which can enhance the manufacture efficiency.

The present invention provides a reflection type liquid crystal display and a manufacture method therefor, in which a color filter and a black matrix are formed on a thin film transistor substrate, and a reflective layer is simultaneously formed during forming a metal wiring, so that the reflection type liquid crystal display can be manufactured in the same manufacture processes as those of the transmission type liquid crystal display.

The reflection type liquid crystal display of the present invention is structurally different from the transmission type liquid crystal display in that it is provided with a reflective layer, and the structure other than the reflective layer is the same.

A gate electrode is usually formed by using a

photolithography technique and patterning a metal layer.

Similarly, the reflective layer can be formed by using the photolithography technique and patterning the metal layer.

For this reason, when a photolithography mask having a

5 pattern with no reflective layer formed thereon and a photolithography mask having a pattern with the reflective layer formed thereon are prepared, by selectively using either one of the two types of masks, the liquid crystal display with the reflective layer formed thereon or the liquid crystal display with no reflective layer formed thereon (i.e., the transmission type liquid crystal display) can be manufactured as occasion demands.

As described above, according to the reflection type liquid crystal display of the present invention, simply by preparing two types of masks different in the pattern, the reflection type liquid crystal display can be manufactured in the same manufacture processes as those of the transmission type liquid crystal display.

The reflective layer is preferably formed of
20 aluminum or aluminum alloy.

Since the aluminum or the aluminum alloy has a high reflectance, it is appropriate as the reflective layer.

As the aluminum alloy, an alloy of aluminum and neodymium can be selected.

25 It is preferable to dispose a diffusion preventive layer below the reflective layer to prevent the aluminum from being diffused to a lower layer.

For example, the aluminum has a property of being diffused in silicon when in direct contact with the silicon. For this reason, it is preferable to dispose the diffusion preventive layer below the reflective layer of aluminum to prevent the aluminum from being diffused.

As the diffusion preventive layer, for example, a layer of titanium can be used.

A rough portion or a rough portion is formed on a first transparent insulation substrate or a gate insulation film, and the reflective layer is preferably formed to cover the rough portion.

For example, when the reflective layer of a metal is used, surrounding materials, observer's face, and the like are reflected into the reflective layer as in a mirror, which degrades the display quality in some cases. On the other hand, when the rough portion is disposed, the reflective layer functions as a scattering preventive layer, which can suppress the mirroring phenomenon.

This rough portion can be formed from various materials.

For example, it is preferable to select a material which is not deformed in the subsequent heating process, and which contains no high density impurities adversely affecting the liquid crystal display. Examples of the material include a photosensitive resist.

Moreover, the rough portion can be formed by various methods.

For example, the rough portion can be formed by forming an insulation film such as a silicon nitride film, and patterning the insulation film.

Alternatively, the rough portion can be formed by
5 cutting the surface of the first transparent insulation substrate or the gate insulation film.

When the rough portion is formed on the first transparent insulation substrate or the gate insulation film, the surface area of the reflective layer formed on the rough portion is enlarged as compared with when the reflective layer is formed on a flat face. Therefore, the reflection efficiency can be enhanced.
10

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view showing the constitution of a liquid crystal display according to a
15 first embodiment of the present invention.

Fig. 2 is a sectional view showing the constitution of the liquid crystal display according to a
20 second embodiment of the present invention.

Fig. 3 is a sectional view showing the constitution of a transmission type liquid crystal display which can be fabricated in the same processes as those of the first and second embodiments.
25

Fig. 4 is a sectional view showing the constitution of the liquid crystal display according to a third embodiment of the present invention.

Fig. 5 is a sectional view showing the constitution of the transmission type liquid crystal display which can be fabricated in the same processes as those of the third embodiment.

5

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Fig. 1, a liquid crystal layer 33 is held between a thin film transistor substrate (TFT substrate) 60 on which a thin film transistor is formed, and an opposite substrate 61 disposed opposite to the substrate 60.

For the TFT substrate 60, a gate electrode 22 and a reflective layer 23 are simultaneously formed of the same material on a first transparent insulation substrate 21 such as a glass plate. For example, aluminum or aluminum alloy such as aluminum-neodymium alloy is employed.

Although the gate electrode 22 and the reflective layer 23 are formed on the same flat face, they are electrically separated. A gate insulation film 24 is formed on the substrate 21 to cover the gate electrode 22 and the reflective layer 23. Arranged above the gate electrode 22 are a semiconductor layer 25 formed on the gate insulation film 24, and a source electrode 26 and a drain electrode 27 formed in contact with the semiconductor layer 25 on the gate insulation film 24. A passivation film 28 is formed to cover the semiconductor layer 25, the source electrode 26, the drain electrode 27 and the gate insulation film 24.

in common. A black matrix 29 and a color filter 30 are disposed adjacent to each other on the passivation film 28. An overcoat layer 32 is formed to cover the black matrix 29 and the color filter 30 in common, and a transparent pixel 5 electrode 31 connected to the source electrode 26 via a contact hole 26a is formed on the overcoat layer 32. A liquid crystal alignment layer 36 is formed on the pixel electrode 31 to cover the pixel electrode 31. Moreover, the reflective layer 23 has a sufficient size to cover the entire color filter 30.

In the opposite substrate 61, a transparent opposite electrode 34 is formed on a second transparent insulation substrate 35 such as a glass plate. The liquid crystal alignment layer 36 is formed on the opposite electrode 34 to cover the opposite electrode 34.

The TFT substrate 60 and the opposite substrate 61 are disposed so that the liquid crystal alignment layers 36 face each other, and the liquid crystal layer 33 is held between the opposite liquid crystal alignment layers 36.

20 A method of manufacturing the liquid crystal display according to the embodiment will be described hereinafter.

Aluminum is formed into a film on the first transparent insulation substrate 21 by sputtering, and the 25 photolithography technique is used to perform patterning, so that the gate electrode 22 and the reflective layer 23 are simultaneously formed.

The aluminum has a very high reflectance, and is an appropriate material as the reflective layer.

In this case, since pure aluminum easily generates hillocks, and deteriorates yield in producing the liquid crystal display, the aluminum-neodymium alloy with several percents of neodymium mixed therein is preferably used.

Thereafter, a silicon nitride film to form the gate insulation film 24 is formed on the entire surface by a chemical vapor developing method (hereinafter referred to as CVD).

Furthermore, a non-doped amorphous silicon (hereinafter referred to as "a-Si"), and an n+ type doped amorphous silicon (hereinafter referred to as "n+ type a-Si") are continuously formed into films on the gate insulation film 24 by CVD, and these films are subjected to a patterning to form the semiconductor layer 25. The n+ type a-Si ensures the ohmic contact of the drain electrode 27 and the source electrode 26 with the a-Si.

Chromium is formed into a film on the semiconductor layer 25 by sputtering, and the chromium film is subjected to patterning to form the drain electrode 27 and the source electrode 26.

Thereafter, a gas system for etching the n+ type a-Si is used to perform dry etching to remove the n+ type a-Si between the drain electrode 27 and the source electrode 26. This prevents a current from directly flowing between the source electrode 26 and the drain

electrode 27 via the n+ type a-Si.

Subsequently, the silicon nitride is formed into a film by CVD, and the silicon nitride film is subjected to patterning to form the passivation film 28. The 5 passivation film 28 prevents impurities such as ions from entering the semiconductor layer 25 and prevents the thin film transistor from causing its operation failure.

As described above, the thin film transistor (TFT) is formed on the first transparent insulation substrate 21.

A black resist with a black pigment dispersed in an acrylic photosensitive polymer is subjected to patterning on the upper face of the thin film transistor area fabricated as described above by the photolithography process, to form the black matrix 29.

The black resist having a high insulation property is used. When the insulation property of the black resist is low, the black matrix 29 on the thin film transistor has a certain electric potential, the back channel of the thin film transistor is activated, and excellent display cannot 20 be realized.

Subsequently, acrylic photosensitive polymer materials with red (R), green (G) and blue (B) pigments dispersed therein are subjected to patterning by three photolithography processes, to form the color filter 30 25 adjacent to the black matrix 29.

Thereafter, a photosensitive acrylic polymer having a high transparency is subjected to patterning by

the photolithography process, to form the overcoat layer 32 on the black matrix 29 and the color filter 30. The overcoat layer 32 prevents the impurities such as ions eluted from the color filter 30 from being mixed into the liquid crystal layer 33, can uniformly control the thickness of the liquid crystal layer 33 to flat the surface of the TFT substrate 60, suppresses the occurrence of discretion, and contributes to the realization of excellent display.

For the color filter 30 and the overcoat layer 32, the material which does not change in properties in temperatures of 200 degrees or more is selected so as to sufficiently withstand the subsequent heating process.

Moreover, in the embodiment, the acrylic polymer is used as the material of the overcoat layer 32, but any insulation film, such as polysilazane, can be used as long as it is transparent and can be formed by spin coating.

Alternatively, the insulation film formed by sputtering or CVD may be polished to form a flattened film. According to this method, since a very flat film face can be formed, a high-precision patterning can be performed, and a liquid crystal display superior in heat resistance can be obtained.

The pixel electrode 31 is formed by forming ITO (Indium-Tin-Oxide) into a film on the overcoat layer 32 by sputtering, and subjecting the film to patterning.

On the second transparent insulation substrate 35

forming the opposite substrate 61, ITO is formed into a film by sputtering, to form the opposite electrode 34.

The liquid crystal alignment layers 36 of polyimide are formed on the TFT substrate 60 and the 5 opposite substrate 61 formed as described above, respectively.

After both substrates 60, 61 are rubbing-treated, so that a nematic liquid crystal containing a chiral agent with a black two-tone pigment added thereto (hereinafter referred to as GH nematic liquid crystal) is twisted and oriented at an angle of 270 degrees, polymer beads having diameters fit for a gap are scattered over the entire surface as a spacer. Two substrates 60, 61 are overlapped and bonded so that the liquid crystal alignment layers 36 face each other, and the GH nematic liquid crystal is injected between the two substrates 60 and 61.

In the embodiment, the GH nematic liquid crystal is used as the liquid crystal layer 33, but a polymer dispersed type liquid crystal, a 45 degree twisted/oriented 20 nematic liquid crystal using one polarizing plate, and the like may be used as the reflection type liquid crystal layer.

The reflection type liquid crystal display of the embodiment is fabricated as described above.

25 The effect of the liquid crystal display according to the embodiment will be described hereinafter.

First, in the liquid crystal display of the

embodiment, since the color filter 30 and the black matrix
29 are formed as the elements constituting the thin film
transistor substrate 60, it is unnecessary to provide a
margin in consideration of the overlap deviation of the
5 thin film transistor substrate 60 and the opposite
substrate 61.

As a result, in the liquid crystal display of the
embodiment, the aperture ratio can be raised, and a
brighter display can be performed.

Fig. 3 is a sectional view showing the
constitution of a transmission type liquid crystal display.
As apparent from the comparison of Figs. 1 and 3, the
liquid crystal display of the embodiment is different from
the transmission type liquid crystal display shown in Fig.
3 only in that it is provided with the reflective layer 23.
The constitution of the liquid crystal display of the
embodiment other than the reflective layer 23 is the same
as that of the transmission type liquid crystal display.

The gate electrode 22 is usually formed by using
20 the photolithography technique and patterning the metal
layer. Similarly, the reflective layer 23 can be formed by
using the photolithography technique and patterning the
metal layer. For this reason, when the photolithography
mask having a pattern with no reflective layer 23 and the
25 photolithography mask having a pattern with the reflective
layer 23 formed thereon are prepared, by selectively using
either one of the two types of masks, the liquid crystal

display with the reflective layer 23 formed thereon (i.e., the reflection type liquid crystal display) or the liquid crystal display with no reflective layer 23 formed thereon (i.e., the transmission type liquid crystal display) can be
5 manufactured as occasion demands.

As described above, according to the reflection type liquid crystal display of the embodiment, simply by preparing two types of masks different in the pattern, the reflection type liquid crystal display can be manufactured in the same manufacture processes as those of the
10 transmission type liquid crystal display.

When the liquid crystal displays different in the manufacture processes for reasons such as the difference of the layer structure are manufactured on the same manufacture line, the optimum conditions in forming the films or performing the etching or the like also change, and the setting of the manufacture device has to be changed.
15 Since the setting change requires much time, the production efficiency is remarkably deteriorated. Moreover, since the manufacture device of the liquid crystal display is very expensive, the addition of the manufacture device to
20 eliminate the setting change-over results in a manufacture cost increase.

According to the embodiment, since the reflection type liquid crystal display is the same as the transmission type liquid crystal display in the manufacture processes, the reflection type liquid crystal display can also be
25

manufactured using the same manufacture line as that of the transmission type liquid crystal display without changing the setting of the manufacture device.

Aluminum or aluminum alloy has a high reflectance, and is an appropriate material as the reflective layer. However, the aluminum is diffused in silicon when directly contacting the silicon, which is a cause of disturbance in transistor operation. Therefore, a diffusion preventive film is usually formed between aluminum and silicon to prevent aluminum from being dispersed in silicon.

In the embodiment shown in Fig. 1, since the gate insulation film 24 serves as the diffusion preventive film, it is unnecessary to form a new diffusion preventive layer. Specifically, a high-reflection, large-luminance liquid crystal display can be obtained without increasing the manufacture processes.

Fig. 2 is a sectional view showing the constitution of the liquid crystal display according to a second embodiment of the present invention.

The liquid crystal display of the second embodiment is different from the liquid crystal display of the first embodiment in that concave/convex portions or rough portions 100 are formed on the first transparent insulation substrate 21. Except the formation of the rough portions 100, the liquid crystal display of the second embodiment has the same constitution as that of the liquid crystal display of the first embodiment.

The manufacture processes of the rough portions 100 or uneven portions will be described hereinafter. The manufacture processes other than the process of forming the rough portions 100 are the same as those in the liquid crystal display according to the first embodiment.

First, a silicon nitride film is formed on the transparent insulation substrate 21 by CVD, and is subjected to patterning, to form the rough portions 100.

The silicon nitride film formed by CVD is used as the material of the rough portions 100, but any material can be used as long as it is not deformed in the subsequent heating process or contains no high-density impurities adversely affecting the liquid crystal display. For example, when the photosensitive resist, and the like are used, high and large rough portions 100 can easily be fabricated.

Moreover, the rough portions 100 can be formed by cutting the surface of the transparent insulation substrate 21.

The subsequent processes are the same as those in the first embodiment.

According to the liquid crystal display of the second embodiment, in addition to the effects obtained by the liquid crystal display of the first embodiment, the following effects can be obtained.

For example, when the reflective layer of a metal or the like is used in the reflection type liquid crystal

display, surrounding materials, observer's face, and the like are reflected as in a mirror, which degrades the display quality in some cases. On the other hand, in the second embodiment, since the rough portions 100 are disposed, the reflective layer 23 functions as a scattering preventive layer, so that the mirroring phenomenon is suppressed.

Therefore, according to the second embodiment, there is provided a high-luminance reflection type liquid crystal display without any mirroring phenomenon.

The reflection type liquid crystal display provided with the reflective layer having the rough portions is also disclosed in Japanese Patent Application Laid-Open No. 146087/1997, but it is not constituted to be manufactured together with the transmission type liquid crystal display on the same manufacture line in the same manner as the above-described reflection type liquid crystal display.

Fig. 3 is a sectional view showing the constitution of the transmission type liquid crystal display. As apparent from the comparison of Figs. 2 and 3, the liquid crystal display of the second embodiment is different from the transmission type liquid crystal display shown in Fig. 3 in that it is provided with the rough portions 100 and the reflective layer 23. The constitution of the liquid crystal display of the second embodiment other than the rough portions 100 and the reflective layer

23 is the same as that of the transmission type liquid crystal display.

Therefore, in the same manner as the first embodiment, when the photolithography mask having the pattern with no reflective layer 23 and the photolithography mask having the pattern with the reflective layer 23 formed thereon are prepared, by selectively using either one of the two types of masks, the liquid crystal display with the reflective layer 23 formed thereon (i.e., the reflection type liquid crystal display) or the liquid crystal display without the reflective layer 23 (i.e., the transmission type liquid crystal display) can be manufactured as occasion demands.

Particularly, when the liquid crystal display provided with both the rough portions 100 and the reflective layer 23 is manufactured, the process for forming the rough portions 100 is merely added before the process for forming the reflective layer 23, and the subsequent manufacture processes are the same as those of the transmission type liquid crystal display.

As described above, according to the reflection type liquid crystal display of the second embodiment, only by adding the process of forming the rough portions, the reflection type liquid crystal display can be manufactured under the same manufacture processes as those of the transmission type liquid crystal display.

According to the second embodiment, since the

reflection type liquid crystal display is the same as the transmission type liquid crystal display in the manufacture processes, the reflection type liquid crystal display which can prevent the mirroring phenomenon can also be
5 manufactured using the same manufacture line as that of the transmission type liquid crystal display without changing the setting of the manufacture device.

Fig. 4 is a sectional view showing the constitution of the liquid crystal display according to a
10 third embodiment of the present invention.

In the reflection type liquid crystal display, the liquid crystal layer 33 is held between the thin film transistor substrate (TFT substrate) 60 on which the thin film transistor is formed and the opposite substrate 61.

For the TFT substrate 60, first, the gate electrode 22 is formed of aluminum or aluminum alloy such as aluminum-neodymium alloy on the first transparent insulation substrate 21 such as a glass plate, and the gate insulation film 24 is formed on the first transparent insulation substrate 21 to cover the gate electrode 22.
15
20 Arranged above the gate electrode 22 are the semiconductor layer 25 formed on the gate insulation film 24, and the source electrode 26 and the drain electrode 27 formed in contact with the semiconductor layer 25 on the gate
25 insulation film 24. The reflective layer 23 is formed integrally with the source electrode, and extends onto the gate insulation film 24. The passivation film 28 is formed

to cover the semiconductor layer 25, the source electrode 26, the drain electrode 27 and the reflective layer 23 in common. The black matrix 29 and the color filter 30 are disposed adjacent to each other on the passivation film 28.

5 The overcoat layer 32 is formed to cover the black matrix 29 and the color filter 30 in common. The pixel electrode 31 connected to the source electrode 26 via the contact hole 26a is formed on the overcoat layer 32.

As described later, the reflective layer 23 is simultaneously formed of the same material as that of the source electrode 26. The reflective layer 23 has a sufficient size to cover the entire area of the color filter 30. Moreover, the liquid crystal alignment layer 36 is formed on the pixel electrode 31 to cover the pixel electrode 31.

For the opposite substrate 61, the liquid crystal alignment layer 36 is formed to cover the opposite electrode 34 formed on the second transparent insulation substrate 35 such as a glass plate.

20 The TFT substrate 60 and the opposite substrate 61 are disposed so that the liquid crystal alignment layers 36 face each other, and the liquid crystal layer 33 is held between the opposite liquid crystal alignment layers 36.

A method of manufacturing the liquid crystal display according to the third embodiment will be described hereinafter.

On the first transparent insulation substrate 21

aluminum is formed into a film by sputtering, and the photolithography technique is used to perform patterning, so that the gate electrode 22 is formed.

Thereafter, silicon nitride to form the gate
5 insulation film 24 is formed into a film on the entire surface by CVD. On the gate insulation film 24, the non-doped a-Si film and the n+ type a-Si film are continuously formed by CVD, and these films are subjected to patterning to form the semiconductor layer 25.

10 The n+ type a-Si film ensures the ohmic contact of the drain electrode 27 and the source electrode 26 with the a-Si film.

15 Subsequently, a titanium film 27a and an aluminum film 27b are formed on the semiconductor layer 25 and the gate insulation film 24 by sputtering, and these films 27a, 27b are subjected to patterning to form the drain electrode 27, the source electrode 26 and the reflective layer 23.

20 The titanium film is disposed under the aluminum film in order to prevent aluminum from being diffused in the a-Si film and from disturbing the transistor operation.

25 Thereafter, in the gas system in which the n+ type a-Si film can be etched, dry etching is performed to remove the n+ type a-Si film between the drain electrode 27 and the source electrode 26. This prevents a current from directly flowing between the source electrode 26 and the drain electrode 27 via the n+ type a-Si film.

Subsequently, silicon nitride is formed into a

film by CVD, and the passivation film 28 is formed by patterning. The passivation film 28 prevents the impurities such as ions from entering the semiconductor layer 25 and prevents the thin film transistor from causing 5 its operation failure.

The thin film transistor is formed on the first transparent insulation substrate 21 as described above.

Subsequently, a black resist with a black pigment dispersed in an acrylic photosensitive polymer is subjected 10 to patterning on the passivation film 28 by the photolithography process, to form the black matrix 29.

The black resist having a high insulation property is used. When the insulation property of the black resist is low, the black matrix 29 on the thin film transistor has 15 a certain electric potential, the back channel of the transistor is activated, and excellent display cannot be realized.

Subsequently, acrylic photosensitive polymer materials with the pigments of three primary colors, red 20 (R), green (G) and blue (B) dispersed therein are subjected to patterning by three photolithography processes, to form the color filter 30 adjacent to the black matrix 29 on the passivation film 28. Subsequently, a photosensitive acrylic polymer having a high transparency is subjected to 25 patterning by the photolithography process, to form the overcoat layer 32 on the black matrix 29 and the color filter 30.

The overcoat layer 32 prevents the impurities such as ions eluted from the color filter 30 from being mixed into the liquid crystal layer 33, can uniformly control the thickness of the liquid crystal layer 33 to flat the surface of the TFT substrate 60, suppresses the occurrence of discretion, and contributes to the realization of excellent liquid crystal display.

For the color filter 30 and the overcoat layer 32, the material which does not change in properties in temperatures of 200 degrees or more is selected so as to sufficiently withstand the subsequent heating process.

In the third embodiment, the acrylic polymer is used as the material of the overcoat layer 32, but any insulation film can be used as long as it is transparent and can be formed by spin coating. For example, polysilazane, and the like can be used.

Alternatively, the insulation film formed by sputtering or CVD may be polished to form a flattened film. According to this method, since a very flat film face can be formed, a high-precision patterning can be performed, and a superior heat resistance can be obtained.

Subsequently, ITO (Indium-Tin-Oxide) is formed into a film on the overcoat layer 32 by sputtering, and the film is subjected to patterning to form the pixel electrode 31.

The TFT substrate 60 is formed as described above. On the second transparent insulation substrate 35,

ITO is formed into a film by sputtering, to form the opposite electrode 34, so that the opposite substrate 61 is obtained.

The liquid crystal alignment layers 36 of polyimide are formed on the TFT substrate 60 and the opposite substrate 61 formed as described above, respectively. After both substrates 60, 61 are rubbing-treated, so that a nematic liquid crystal containing a chiral agent with a black two-tone pigment added thereto (GH nematic liquid crystal) is twisted and oriented at an angle of 270 degrees, polymer beads having diameters fit for a gap are scattered over the entire surface as a spacer. Subsequently, both substrates 60, 61 are overlapped and bonded so that the liquid crystal alignment layers 36 face each other, and the GH nematic liquid crystal is injected between the substrates 60 and 61.

In the third embodiment, the GH nematic liquid crystal is used as the liquid crystal layer 33, but a polymer dispersed type liquid crystal, a 45 degree twisted/oriented nematic liquid crystal using one polarizing plate, and the like may be used as the reflection type liquid crystal layer.

The reflection type liquid crystal display of the third embodiment is fabricated as described above.

The effect of the liquid crystal display according to the third embodiment will be described hereinafter.

First, in the liquid crystal display of the third

embodiment, since the color filter 30 and the black matrix 29 are formed as the elements constituting the thin film transistor substrate 60, it is unnecessary to provide a margin in consideration of the overlap deviation of the 5 thin film transistor substrate 60 and the opposite substrate 61.

As a result, in the liquid crystal display of the third embodiment, the aperture ratio can be raised, and a high luminance display can be performed.

Fig. 5 is a sectional view showing the constitution of the transmission type liquid crystal display. As apparent from the comparison of Figs. 4 and 5, the liquid crystal display of the third embodiment is different from the transmission type liquid crystal display shown in Fig. 5 only in that it is provided with the reflective layer 23. The constitution of the liquid crystal display of the third embodiment other than the reflective layer 23 is the same as that of the transmission type liquid crystal display.

The drain electrode 27 and the source electrode 26 are usually formed by using the photolithography technique and patterning the metal layer. Similarly, the reflective layer 23 can also be formed by using the photolithography technique and patterning the metal layer. For this reason, 25 when the photolithography mask having the pattern with no reflective layer 23 and the photolithography mask having the pattern with the reflective layer 23 formed thereon are

prepared, by selectively using either one of the two types of masks, the liquid crystal display with the reflective layer 23 formed thereon (i.e., the reflection type liquid crystal display) or the liquid crystal display without the reflective layer 23 (i.e., the transmission type liquid crystal display) can be manufactured as occasion demands.

As described above, according to the reflection type liquid crystal display of the third embodiment, only by preparing two types of masks different in the pattern, the reflection type liquid crystal display can be manufactured in the same manufacture processes as those of the transmission type liquid crystal display.

According to the third embodiment, since the reflection type liquid crystal display is the same as the transmission type liquid crystal display in the manufacture processes, the reflection type liquid crystal display can be manufactured using the same manufacture line as that of the transmission type liquid crystal display without changing the setting of the manufacture device..

As described above, according to the present invention, in the reflection type liquid crystal display in which the color filter and the black matrix are formed on the thin film transistor substrate, the reflective layer is simultaneously formed with the same material as that of the metal wiring during laying the metal wiring. For this reason, since the high-reflectance aluminum reflective layer can be prepared by the same manufacture method as

that of the transmission type liquid crystal display without changing the manufacture processes, the high-performance reflection type liquid crystal display can be produced at low costs.

WHAT IS CLAIMED IS:

1. A reflection type liquid crystal display,
comprising: a pair of substrates disposed opposite to each
5 other via a liquid crystal; a plurality of switching
elements formed on one surface of said pair of substrates;
a reflective layer constituted of the same material as a
material constituting said switching element and
simultaneously formed during formation of said switching
10 elements; and a transparent pixel electrode formed on said
reflective layer via an insulation layer and connected to
one electrode constituting said switching element.

2. The reflection type liquid crystal display
according to claim 1, wherein said switching element is a
thin film transistor, and said reflective layer is formed
of the same material as a material of a gate electrode of
said thin film transistor and constituted on the same plane
as a plane of said gate electrode.

3. The reflection type liquid crystal display
according to claim 1, wherein said switching element is a
thin film transistor, and said reflective layer is formed
of the same material as a material of a source/drain
25 electrode of said thin film transistor and formed on the
same plane as a plane of said source/drain electrode.

4. The reflection type liquid crystal display according to claim 1, wherein a color filter layer is disposed between said reflective layer and said transparent pixel electrode.

5

5. The reflection type liquid crystal display according to claim 1, wherein a shielding layer is disposed on an area of said switching elements.

10 6. The reflection type liquid crystal display according to claim 2, wherein said thin film transistor comprises a gate electrode electrically connected to a scanning line, a gate insulation film formed to cover said gate electrode, a semiconductor layer formed on said gate insulation film, a drain electrode electrically connected to a signal line, and a source electrode electrically connected to said transparent pixel electrode, and said reflective layer is electrically separated from said gate electrode.

15 20

7. The reflection type liquid crystal display according to claim 3, wherein said thin film transistor comprises a gate electrode electrically connected to a scanning line, a gate insulation film formed to cover said gate electrode, a semiconductor layer formed on said gate insulation film, a drain electrode electrically connected to a signal line, and a source electrode electrically connected to a signal line, and a source electrode electrically

connected to said transparent pixel electrode, and said reflective layer is formed on said gate insulation film, constituted of the same material as a material constituting said drain electrode, simultaneously formed during formation of said drain electrode and electrically connected to said drain electrode.

8. The reflection type liquid crystal display according to claim 1, wherein said reflective layer is 10 formed of aluminum or aluminum alloy.

9. The reflection type liquid crystal display according to claim 8, wherein said aluminum alloy is an 15 alloy of aluminum and neodymium.

10. The reflection type liquid crystal display according to claim 8, wherein a diffusion preventive layer is disposed below said reflective layer to prevent said aluminum from being diffused to a lower layer.

11. The reflection type liquid crystal display according to claim 10, wherein said diffusion preventive 20 layer is formed of titanium.

12. The reflection type liquid crystal display according to claim 1, wherein a rough portion is formed in 25 the lower layer of said reflective layer, and said

reflective layer is formed to cover said rough portion.

13. The reflection type liquid crystal display
according to claim 12, wherein said rough portion is formed
5 of a material which is not deformed in a heating process
performed later and which does not contain high density
impurities adversely affecting the liquid crystal display.

14. The reflection type liquid crystal display
according to claim 12, wherein said rough portion is formed
10 by forming an insulation film and patterning the insulation
film.

15. The reflection type liquid crystal display
according to claim 12, wherein said rough portion is formed
by cutting the surface of the lower layer of said
reflective layer.

16. A method of manufacturing a reflection type
liquid crystal display, comprising the steps of: forming a
20 plurality of switching elements on one surface of a liquid
crystal display panel substrate; forming a reflective layer
with the same material as a material constituting said
switching element during the step of forming said plurality
25 of switching elements; forming an insulation layer on said
reflective layer; and forming a transparent pixel electrode
on said insulation layer so as to be electrically connected

to an electrode constituting said switching element.

17. The method of manufacturing the reflection
type liquid crystal display according to claim 16, wherein
5 said switching element is a thin film transistor, and said
reflective layer is formed of the same material as a
material of said gate electrode and formed on the same
plane as a plane of said gate electrode in the step of
forming the gate electrode of said thin film transistor.

10
18. The method of manufacturing the reflection
type liquid crystal display according to claim 16, wherein
said switching element is a thin film transistor, and said
reflective layer is formed of the same material as a
material of a source/drain electrode and formed on the same
plane as a plane on which said source/drain electrode is
15 formed in the step of forming the source/drain electrode of
said thin film transistor.

20
19. The method of manufacturing the reflection
type liquid crystal display according to claim 17,
comprising the step of forming a rough portion on said
substrate before the step of forming said reflective layer,
so that said reflective layer is formed to cover said rough
25 portion.

20. The method of manufacturing the reflection

type liquid crystal display according to claim 18,
comprising the step of forming a rough portion on said gate
insulation film before the step of forming said reflective
layer, so that said reflective layer is formed to cover
5 said rough portion.

21. The method of manufacturing the reflection
type liquid crystal display according to claim 16,
comprising the step of forming a color filter layer on said
10 insulation layer before the step of forming said
transparent pixel electrode, so that a second insulation
layer is formed on said color filter layer to form said
transparent pixel electrode.

22. The method of manufacturing the reflection
type liquid crystal display according to claim 16,
comprising the step of forming a shielding film on said
switching elements before the step of forming said
transparent pixel electrode.
15

23. The method of manufacturing the reflection
type liquid crystal display according to claim 17,
comprising the steps of: preparing a first mask for
photolithography having a pattern to simultaneously form
25 said gate electrode and the reflective layer on said
substrate and a second mask for photolithography having a
pattern to form only said gate electrode on said substrate;

and using either one of said first and second masks to form both said gate electrode and said reflective layer, or only said gate electrode on said substrate.

5 24. The method of manufacturing the reflection type liquid crystal display according to claim 18,
comprising the steps of: preparing a first mask for
photolithography having a pattern to form said source/drain
electrode and said reflective layer on said gate insulation
10 film and a second mask for photolithography having a
pattern to form only said source/drain electrode on said
gate insulation film; and using either one of said first
and second masks to form both said source/drain electrode
and said reflective layer, or said source/drain electrode
15 on said gate insulation film.

ABSTRACT OF THE DISCLOSURE

In order to realize the manufacture of a reflection type liquid crystal display in the same
5 manufacture processes as those of a transmission type liquid crystal display, a photolithography mask capable of forming both a gate electrode 22 and a reflective layer 23, and a photolithography mask capable of forming only the gate electrode 22 are prepared, and by using either one of the masks, the reflection type liquid crystal display in which both the gate electrode 22 and the reflective layer 23 are formed on a transparent insulation substrate 21, and the transmission type liquid crystal display in which only the gate electrode 22 is formed are selectively
10 manufactured.

15

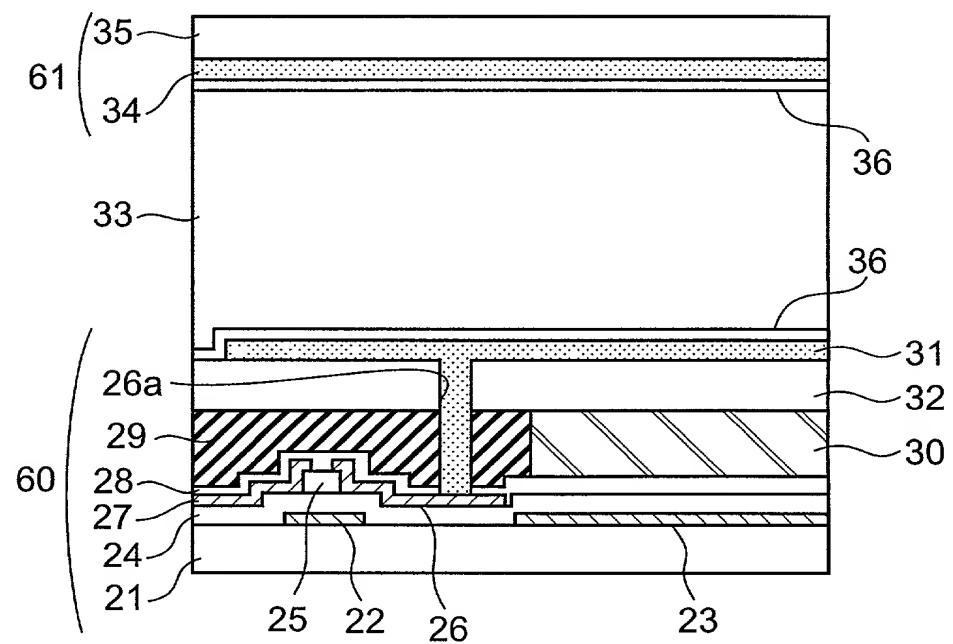


Fig.1

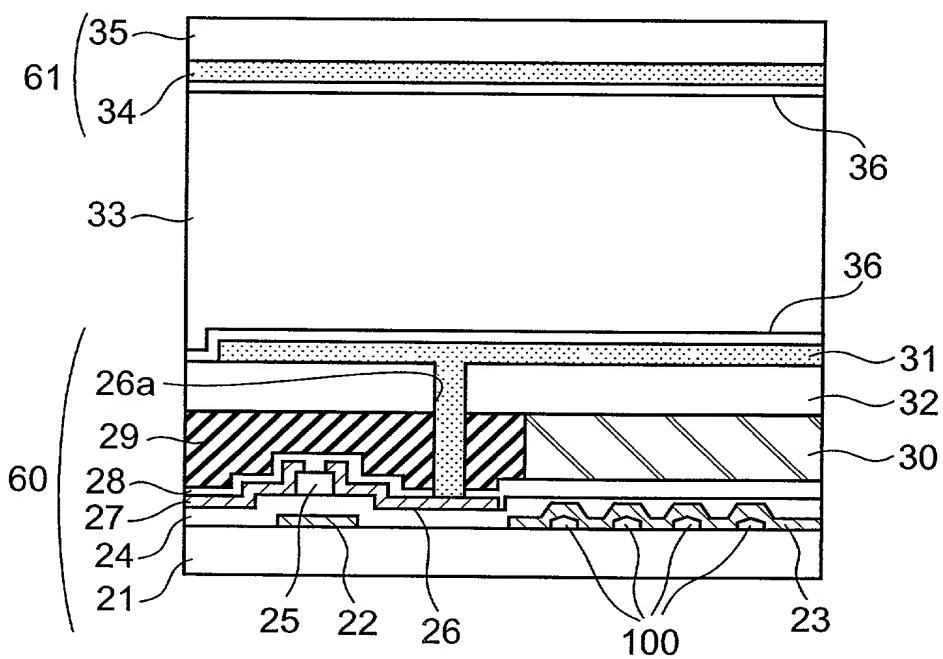


Fig.2

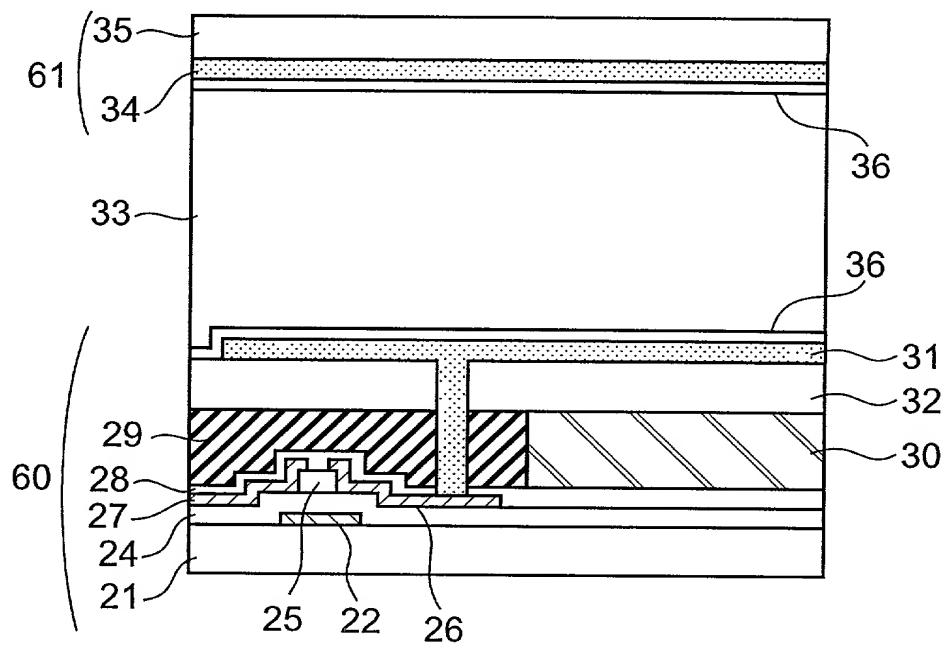


Fig.3

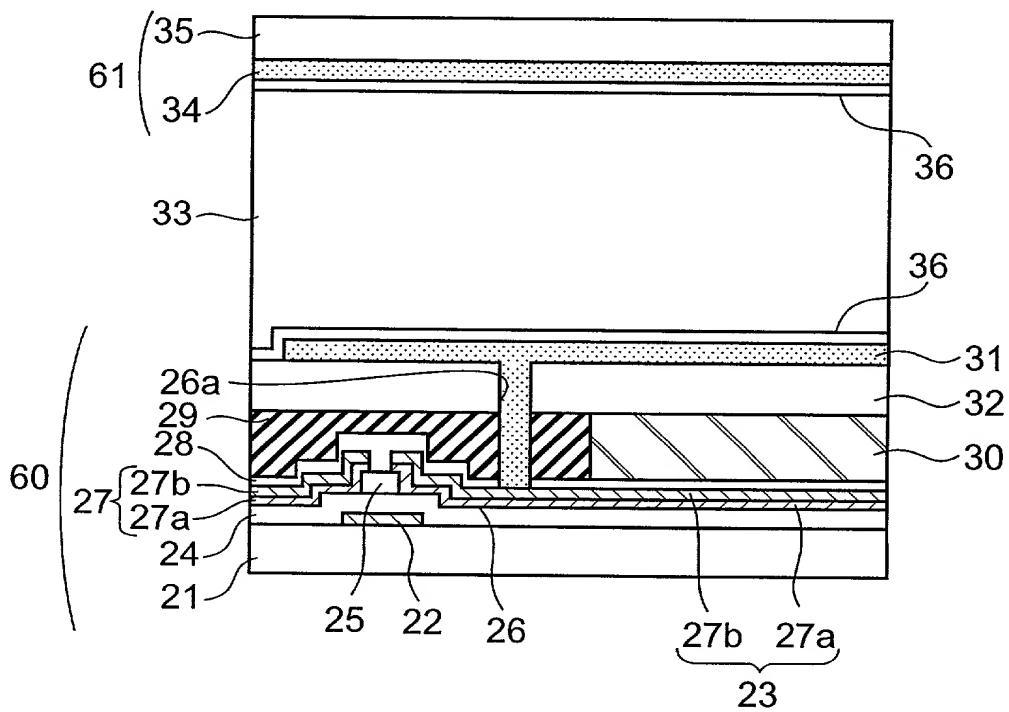


Fig.4

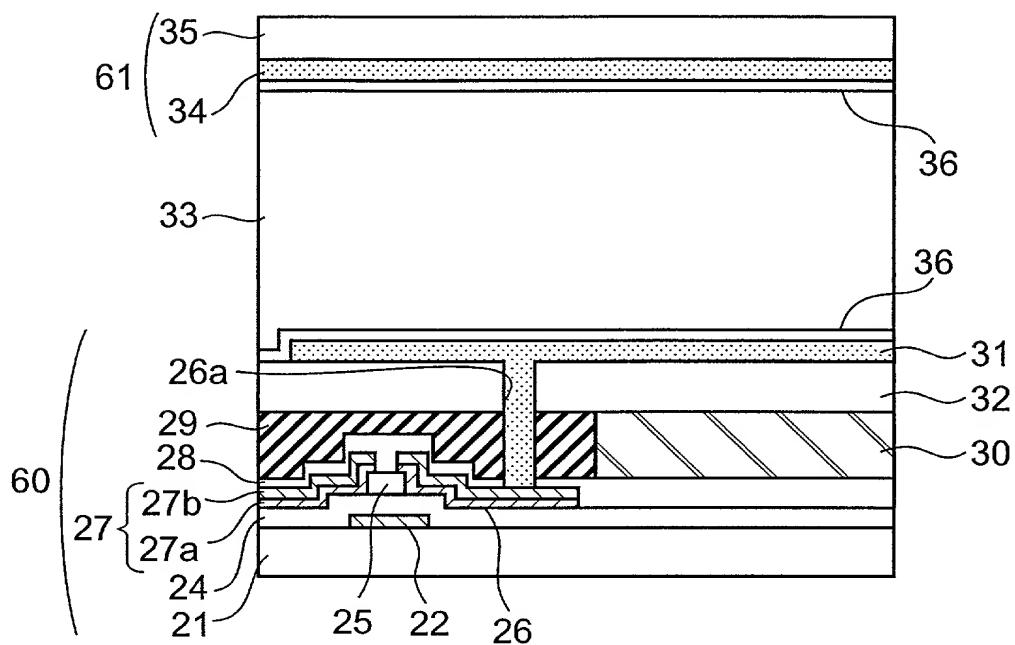


Fig.5

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

REFLECTION TYPE LIQUID CRYSTAL DISPLAY PROVIDED WITH TRANSPARENT PIXEL ELECTRODE AND
MANUFACTURE METHOD THEREOF
the specification of which (check one)

is attached hereto;
 was filed on _____ as United States Application Number or PCT International Application Number
on _____, and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulation, § 1.56. I hereby claim foreign priority benefits under Title 35, United States Code, § 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate disclosing the subject matter claimed in this application and having a filing date (1) before that of the application on which priority is claimed, or (2) if no priority is claimed, before the filing date of this application.

Prior foreign Application(s)

<u>Number</u>	<u>Country</u>	<u>Day/Month/Year Filed</u>	<u>Priority Claimed</u>
327712/1998	Japan	18/11/1998	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
_____	_____	_____	<input type="checkbox"/> Yes <input type="checkbox"/> No
_____	_____	_____	<input type="checkbox"/> Yes <input type="checkbox"/> No

I hereby claim the benefit under Title 35, United States Code, § 120/365 of any United States application(s) listed below and PCT International Applications listed above or below, and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

<u>(Application Number)</u>	<u>Day/Month/Year Filed</u>	<u>Status (Patented, Pending, Abandoned)</u>
-----------------------------	-----------------------------	--

I hereby appoint Beth E. Arnold, Reg. No. 35,430; Paula A. Campbell, Reg. No. 32,503; Charles H. Cella, Reg. No. 38,099; Edward J. Kelly, Reg. No. 38,936; Donald W. Muirhead, Reg. No. 33,978; Chinh H. Pham, Reg. No. 39,329; Diana M. Steel, Reg. No. 43,153; Philip C. Swain, Reg. No. 32,376; Anita Varma, Reg. No. 43,221; and Matthew P. Vincent, Reg. No. 36,709; as attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

Address all telephone calls to Donald W. Muirhead at telephone number (617) 832-1257. Address all correspondence to:

Patent Group
Foley, Hoag & Eliot LLP
One Post Office Square
Boston, Ma. 02109-2170

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Inventor's signature Hiroyuki Kikkawa  Date 11/9/1999

Full name of sole or first inventor (given name, family name) Hiroyuki Kikkawa

Residence Tokyo, Japan Citizenship Japanese

Post Office Address (include zip code) c/o NEC Corporation, 7-1, Shiba 5-chome, Minato-ku,
Tokyo, Japan

Inventor's signature Michiaki Sakamoto  Date 11/9/1999

Full name of sole or first inventor (given name, family name) Michiaki Sakamoto

Residence Tokyo, Japan Citizenship Japanese

Post Office Address (include zip code) c/o NEC Corporation, 7-1, Shiba 5-chome, Minato-ku,
Tokyo, Japan

Inventor's signature _____ Date _____

Full name of sole or first inventor (given name, family name) _____

Residence _____ Citizenship _____

Post Office Address (include zip code) _____

Additional inventors are being named on separately numbered sheets attached hereto.